

Copenhagen Metro, Denmark

Key information	
Network length	20.5 km (mixed alignment)
Operational lines	2
Stations	22 (12 elevated, nine underground and one at-grade)
Ridership	60.9 million passengers in 2016
Rolling stock	34 three-car driverless trains by AnsaldoBreda (now Hitachi Rail)
Fare system	Contactless smartcards (Rejsekort) available as stored-value cards with option of direct debit from bank account, paper tickets, mobile ticketing, passes and Copenhagen Card (for tourists)
Track and Power	1,435 mm; third rail (750V DC)
Technology	ATC, driverless, platform screen doors, moving block signalling
Commencement of operations	October 2002
Opportunities	One new line scheduled to commence operations in July 2019, one branch line in early 2020 and another by 2024

Notes: ATC – automatic train control

Background: Copenhagen is the national capital and the most populous city in Denmark. It has a population of 1.3 million (2017). The city is the economic and financial centre of Denmark and the entire Scandinavian–Baltic region. Its economy is based on the services sector, especially transport, communications, trade and finance. Tourism is an increasingly important sector of the economy. The Copenhagen metropolitan area consists of 34 municipalities and a population of 2.2 million (2017).

The metrorail system serves Copenhagen, Frederiksberg and Tårnby. It is operational 24 hours a day throughout the year.

Key players: Metroselskabet is the owner and developer of the system. The company is owned jointly by the Copenhagen Municipality (50 per cent), the Ministry of Transport (41.7 per cent) and the Frederiksberg Municipality (8.3 per cent).

Italy-based Ansaldo STS operates the system under contract with Metroselskabet. The company has subcontracted the service to Metro Service since 2002 and up to mid-2024.

Metro Service is a joint venture (JV) of Italy's AziendaTrasporti Milanesi (ATM) and Ansaldo STS. It secured the contract to operate the system for five years in 2002, another three years in 2007, up to 2015 in 2010, up to 2019 in 2015 and up to mid-2024 in 2017.

Key contractors: COWI A/S (earlier known as COWI Consulting Engineers and Planners AS) was the consulting engineer.

COMET (Copenhagen Metro Construction Group) is the construction contractor. It comprises UK-based Soletanche Bachy Limited, UK-based Tarmac Construction Limited, France-based SAE International, Italy-based Astaldi SpA, Ilbau Gesellschaft GmbH and Denmark-based NCC Rasmussen & Schjøtz A/S.

Network: The system comprises two lines, M1 and M2, which together span 20.5 km and cover 22 stations. The lines were built between 2002 and 2007.

Of the total network length, about 10 km of track (7.4 km shared and 2.6 km exclusive) and nine stations are underground. Table 1 provides the network details.

Table 1: Current network

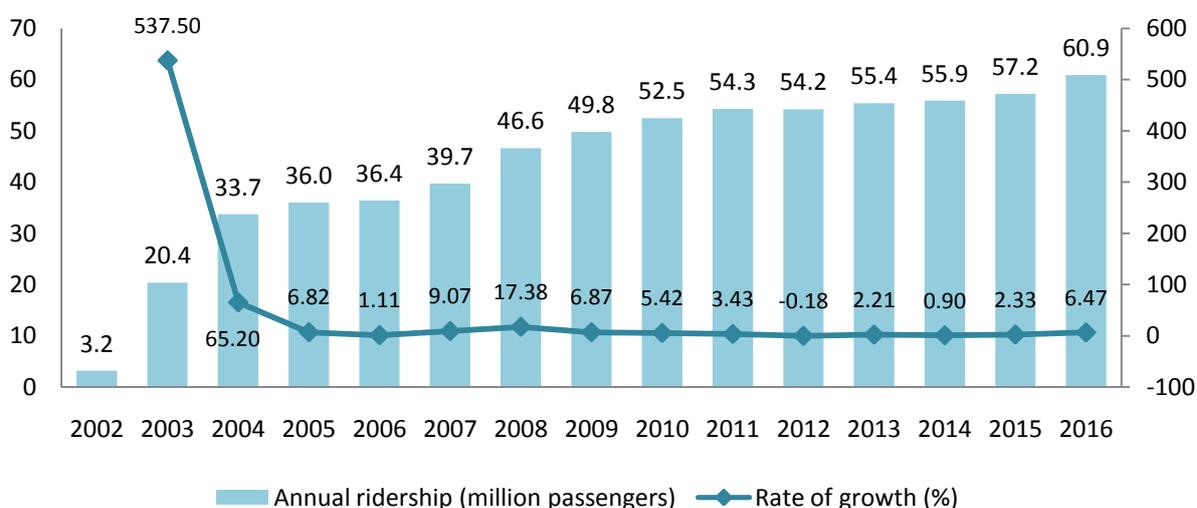
Line	Route	Length (km)			Stations		
		Shared track	Exclusive track	Total	Shared track (underground)	Exclusive track	Total
M1	Vanløse to Vestamager	7.4	6.3	13.7	9	6	15
M2	Vanløse to Lufthavnen (Copenhagen Airport)	7.4	6.8	14.2	9	7	16
Total	-	7.4	13.1	20.5	9	13	22

Source: Metroselskabet

The Vanløseto-Christianshavn section, which spans 7.4 km and covers nine stations, is common to both lines. From the Christianshavn station, Line M1 spans from Ørestad to Vestamager, while Line M2 spans from Østamager to the Copenhagen Airport. The metro is integrated with other public transport systems, including the S-train, DSB trains and Movia buses. Service is provided 24x7.

Ridership: In 2016, the average weekday ridership was 200,000 passengers on Lines M1 and M2. The annual ridership on the metro system was over 60.9 million passengers, an increase of 4.9 per cent compared to 2015. Figure 1 represents the annual ridership and passenger growth rate of the system since its commencement in October 2002.

Figure 1: Annual ridership and growth rate for 2002-16



Source: <http://www.m.dk/#!/om+metroen/facts+om+metroen/statistik/passageral>

By 2035, the average weekday trips on Lines M1 and M2 is anticipated to reach 290,000 passengers, which is around 89 million passengers per year.

Rolling stock and technology: AnsaldoBreda (now known as Hitachi Rail) has supplied 34 three-car driverless trains. Italy-based Italdesign Giugiaro has designed the trains.

Table 2 provides details of rolling stock.

Table 2: Rolling stock details

Parameter	Details
Supplier	AnsaldoBreda (now known as Hitachi Rail)
Length	39 metres
Width	2.65metres
Height	3.4 metres
Floor height (above tracks)	85 cm (same height as all platforms)
Estimated weight	52 ton
Carrying capacity	300 passengers (96 seated and 204 standing)
Maximum speed	80 km/hr
Doors	2 x 6 pieces sliding doors 16-cm wide
Bogie	4-piece bogies with 65-cm wheel pairs
Engine	6 pieces 105 kW asynchronous motors bogie-mounted
Clutch	Central connection with deformation and anti-climb protection
Traction Control	3 pieces of insulated-gate bipolar transistor (IGBT) based inverters

Source: <http://www.m.dk/#!/om+metroen/facts+om+metroen/tog/toget+tal>

Tracks are standard gauge (1,435 mm). Power is sourced from the third rail (750 V DC).

Ansaldo STS has provided the automatic train control (ATC) signalling system, which consists of three sub-systems described in Table 3.

Table 3: Description of ATC signalling system supplied by Ansaldo STS

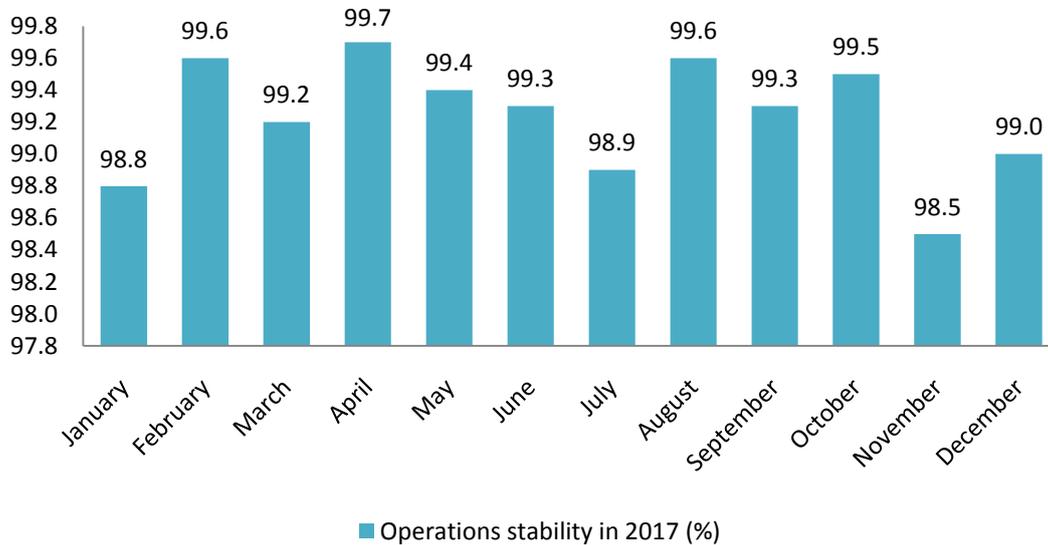
Signalling system component	Function
Automatic train supervisory (ATS)	Monitors all sub-systems and trains in operation
Automatic train operation (ATO)	Acts as an autopilot to control the trains according to a fixed timetable
Automatic train protection (ATP)	Performs safety-related functions such as control of door closing and switches

Source: Global Mass Transit Research

Moving block signalling is used only near stations. All underground stations are equipped with platform screen doors.

Operations: There are around 13,000 departures every day from 22 stations. The system recorded the best operating stability with 99.2 per cent timely departures in 2016 and 2017 and the second best with 98.8 per cent timely departures in 2011 and 2015. Figure 2 represents monthly operation stability statistics for 2017.

Figure 2: Operation stability statistics (2017)



Source: <http://www.m.dk/#!/om+metroen/facts+om+metroen/statistik/driftstabilitet>

Fare system: Contactless smartcards called Rejsekort, paper tickets, mobile ticketing and city passes are used for fare collection.

The fare system is integrated across all modes of public transport in Copenhagen.

Paper tickets and passes

Single-journey tickets and city passes are issued as paper tickets. The passes allow unlimited travel during their validity period (one day, three days or one month).

Flexcard is a pass valid for seven days or longer. Special tickets are available for dogs and bicycles.

Rejsekort

The Rejsekort cards are available for citizens only and require a Danish social security number. The fare is deducted from a prepaid account or directly from the customer’s bank account.

There are three types of smartcard: personal, flex and anonymous. The personal and flex cards are available online.

The smartcards must be validated at the card readers at the start and end of a journey, and the system automatically calculates the fare.

Mobile ticketing

Tickets for the metro, S-train, Danske Statsbaner (DSB) local trains and buses can be purchased using the mobile application (app) called Mobile Tickets Capital/Mobilbilletter Hovedstaden.

Copenhagen Card

It is a tourist card that allows unlimited travel during its validity period (one day, two days, three days and six days) as well as free entry to 75 museums, attractions and restaurants.

Extensions/Capital projects: Metroselskabet has an ambitious long-term plan to extend the metro to the currently unserved areas of Greater Copenhagen.

One new line and two branch lines are planned to be added, which will expand the current network by an additional length of 22.3 km and 24 stations, at an estimated investment of DKK36.3 billion.

Figure 3 illustrates the current network and upcoming metro lines.

Figure 3: Current and future metro lines



Source: <http://www.m.dk/#!/om+metroen/metrobyggeriet>

Cityringen (City Circle Line)

The line will span 15.5 km and cover 17 stations. It will form a fully-underground circular route around the city centre connecting Østerbro, Nørrebro, Vesterbro and Frederiksberg.

The route will comprise two separate lines on shared tracks. These are indicated in Table 4.

Table 4: Sections of Cityringen

Section	Description
Line M3	The line will cover the entire circle in both directions
Line M4	This line will be a pendulum between Nørrebro and København

Source: Global Mass Transit Research

Figure 4 illustrates the interchange points with the existing network.

Figure 4: Cityringen's interchange points



Copenhagen Metro

Line M1 at
KongensNytov

Line M2 at
Frederiksberg



DSB's S-train

København H

Nørrebro

Østerport

Source: Global Mass Transit Research

Figure 5 illustrates the route and stations.

Figure 5: Cityringen map



Source: <http://www.m.dk/#!/om+metroen/metrobyggeriet/om+cityringen>

Construction is currently underway and expected to be completed by July 2019. The average daily ridership is estimated to be 233,800 passengers.

Trains will travel at a speed of 40 km/hr and the journey time for the full circle is expected to be 24 minutes.

Table 5 indicates the estimated ridership by station.

Table 5: Cityringen ridership by station

Station	Estimated daily ridership (passengers)
København H	47,000
Rådhuspladsen	15,000
Gl. Strand	19,000
Kongens Nytorv	53,000
Marmorkirken	13,000
Østerport	19,000
Trianglen	12,000
Poul Henningsens Plads	11,000
Vibenshus Runddel	8,000

Station	Estimated daily ridership (passengers)
Skjolds Plads	7,000
Nørrebro	21,000
Nørrebros Runddel	9,000
Nuuxs Plads	6,000
Aksel Møllers Have	8,000
Frederiksberg	15,000
Frederiksberg Allé	11,000
Enghave Plads	15,000

Source: <http://www.m.dk/#!/om+metroen/metrobyggeriet/om+cityringen/passagertal>

The project was approved by the national government in 2007 and has total construction budget of DKK24.6 billion (2017 prices).

Upon completion of the line, 85 per cent of the residents will have access to a metro or S-train station within 600 metres.

Table 6 indicates the key contracts awarded.

Table 6: Cityringen contracts awarded

Project component	Contractor	Description
Line construction	Copenhagen Metro Team (CMT), a company incorporated for construction of Cityringen and owned by Salini Impregilo	In January 2011, the JV of three Italian companies, Tecnimont Civil Construction, Salini S.p.a. and Seli signed the Build and Design contract for the Cityringen and established CMT. In 2014, Salini and Impregilo merged into one group that now owns CMT. The contract was valued at EUR1.6 billion and included a EUR240-million supplemental agreement for additional works.
Tender package for civil works	JV of COWI (Denmark-based consulting group), Arup (UK-based engineering company) and Systra (France-based engineering firm)	The contract includes preparation of conceptual design and tender documents for civil works.
Construction of 17 stations	CMT	Denmark-based MT Højgaard secured DKK570-million contract in November 2014. Later, in June 2017, MT Højgaard transferred the contract to CMT.
Design and building of the foundations for the underground stations	Italy-based engineering firm Trevi Finanziaria Industriale	The contract value is EUR90 million.
Consultancy services	A consortium of Denmark-based Ramboll and UK-based Atkins	A USD2.6 billion contract was awarded in October 2007.

Project component	Contractor	Description
Provision of power system, communications system, SCADA, CBTC signalling system, a depot and control centre	Italy-based Ansaldo STS	The contract is valued at EUR700 million. The scope of work includes maintenance of the system for five years.
Supply of 28 three-car driverless trains by 2018	Italy-based Ansaldo STS (now Hitachi Rail)	The contract is valued at EUR122 million. All stations will be fitted with platform screen doors. Ansaldo STS will supply 39 trains for Cityringen as well as Nordhavn and Sydhavn extensions.

Notes: JV – joint venture; SCADA – supervisory control and data acquisition; CBTC – communications-based train control
Source: Global Mass Transit Research

In February 2017, CMT completed the tunnelling works. Construction is expected to be completed by 2018.

As of December 2016, 21 trains had been delivered.

Branch lines

Nordhavn extension/ Nordhavnslinjen: This will be a branch of the Cityringen Line and part of the future metro Line M4. The line will extend 2.3 km northeast from the Østerport station on the Cityringen up to Nordhavn (North Harbour), covering two new stations. The stations are Nordhavn and Orientkaj.

The 2.0-km section of the line up to Nordhavn will be underground. The Orientkaj station will be elevated.

Metroselskabet approved the project in February 2012 and is implementing it on a public-private partnership (PPP) basis. The estimated investment is DKK2.6 billion (2016 prices).

Construction started in December 2014 and is scheduled to be completed by December 2019. Commercial services are scheduled to begin by early-2020.

The average daily ridership is expected to be 11,000 passengers. Table 7 indicates the estimated ridership by station station.

Table 7: Nordhavn extension ridership by station

Station	Estimated daily ridership (passengers)
Nordhavn	6,000
Orientkaj	8,000

Source: <http://www.m.dk/#!/om+metroen/metrobyggeriet/om+cityringen/passagertal>

Table 8 indicates the contracts awarded.

Table 8: Nordhavn extension contracts awarded

Contractor	Scope of work
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Contractor	Scope of work
Germany-based Züblin and Hochtief	The EUR150-million contract to construct the underground section was awarded in June 2014 and the contract to construct the 300-metre-long elevated section and the Orientkaj station was awarded in October 2015.
Italy-based Ansaldo STS*	Supply of rolling stock
Ansaldo STS	Installation of railway equipment
JV of Arup and Ramboll	In 2012, the JV was appointed as planning advisor with architectural firm Kobe as sub-consultant to provide architecture, station design, construction planning and other services.

*Ansaldo STS will supply 39 trains for Cityringen as well as Nordhavn and Sydhavn extension

Notes: JV – joint venture

Source: Global Mass Transit Research

Sydhavn extension/ Sydhavnsmetro: It will be an extension of the upcoming M4 Line. The line will span 4.5 km from Havneholmen to Ny Ellebjerg. It will cover five underground stations, namely Havneholmen, EnghaveBrygge, Sluseholmen, Mozart's Plads and NyEllebjerg. Construction cost has been estimated at DKK9.1 billion. Construction is expected to start in 2018 and be completed by 2024.

Figure 6 illustrates the route and stations.

Figure 6: Sydhavn extension map



Source: <http://www.m.dk/#!/om+metroen/metrobyggeriet/sydhavnslinjen>

The daily ridership is estimated to be 29,000 passengers. Table 9 indicates the estimated ridership by station.

Table 9: Sydhavn extension ridership by station

Station	Estimated daily ridership (passengers)
Havneholmen	6,000
Enghave Brygge	4,000
Sluseholmen	6,000
Mozarts Plads	6,000
Ny Ellebjerg	7,000

Source: <http://www.m.dk/#!/om+metroen/metrobyggeriet/om+cityringen/passagertal>

In November 2017, Metroselskabet awarded two contracts for Sydhavn extension.

Table 10 provides details of the contracts awarded.

Table 10: Sydhavn extension contracts awarded in November 2017

Contractor	Scope of work
TUNN3L JV consortium comprising Germany-based Hochtief Infrastructure GmbH and France-based Vinci Consortium Grand Projects	Construction of two 4.5-km long tunnels and five stations
Consortium of Rhomberg Bahntechnik GmbH and EFACEC Engenharia e Sistemas SA	Supply of rail tracks and technology
Ansaldo STS*	Supply of rolling stock

*Ansaldo STS will supply 39 trains for Cityringen as well as Nordhavn and Sydhavn extension

Notes: JV – joint venture

Source: Global Mass Transit Research

Recent developments: In December 2017, Metro Service A/S secured extension to the contract for operations and maintenance of Lines M1 and M2 until mid-2024.

In November 2017, Metroselskabet awarded two contracts for the Sydhavn extension.

(1 EUR [Euro] = 1.22 USD; 1 DKK [Danish Krone] = 0.16 USD)

Project contact(s):

- Frank Jensen, Mayor, City of Copenhagen
- Jørn Neergaard Larsen, Chairman, Metroselskabet
- Henrik Plougmann Olsen, Chief Executive Officer, Metroselskabet
- Erik Skotting, Chief Operating Officer, Metroselskabet

- Andreas Koester, Head of Engineering (Cityringen Metro Project, Nordhavn Extension), Metroselskabet
- Christopher Cox, Project Director Transportation Systems Contracts, Metroselskabet (Cityringen and Nordhavn Metro)
- Donald Okunda, Planner (Cityringen Nordhavn branch), Metroselskabet
- Mikkel Kj r Jensen, Project Director, Metroselskabet
- Uffe Ougaard, Project Manager (O&M of upcoming Cityringen Driverless Metro), Metroselskabet
- Kirsten Eljena Thomsen, Senior Procurement & Contract Manager, Metroselskabet
- Piero Marotta, Chairman of the Board, Metro A/S
- Klaus Aakilde, Chief Financial Officer, Metro A/S